REMARKS

The examiner has objected to claims 9, 11-20 and 22-28 for a variety of informalities. Claims 1-3, 9, 11-13, 19, 21-23 and 29-30 re rejected under 35 U.S.C. §102(e) as being anticipated by US 5872815 to Strolle et al. Claims 4-6, 10, 14-16, 20, 24-25, 27-28, 31-32 and 34-35 are rejected under 35 U.S.C. §103 as being unpatentable over Strolle et al. in view of US 5363408 to Paik et al.

In response, applicants have amended claims 1-4, 9-29, 32 and 35. Claims 1-35, as amended, are active in the application.

SUPPORT IN THE SPECIFICATION FOR THE AMENDED CLAIMS

In a telephone interview with the examiner on May 11, 2004, a proposed amendment to the claims, in substantially the same form as the present amendment was discussed. No agreement was reached. The present amendment is supported in the specification. In particular, in applicant's specification,

> Both input Y_K and output $Y^\wedge_K$ signals from the slicer 50 are used.... A switch 53 selects either soft decision samples, (Y in figure 2 or YK in figure 3) in the acquisition position, and hard decision samples, $Y^\wedge K$, in the tracking position. In accordance with the present invention, switch 53 is set to select either hard decision samples or soft decision samples on a sample by sample basis based on a measure of the quality of the hard decision samples from the decision device 50. (Applicants' specification, page 9, next to last paragraph)

> In such manner, the position of a given sample in the constellation helps determine whether a reliable hard decision can be made based on that sample. The square box decision region 510 provides a basis for a decision rule as to when a reliable hard decision can be made. When the current sample is within the square decision region 510 and the LMS error is below a threshold, t, then reliable hard decisions can be made, the DD-LMS update equation is used, and hard decisions from the slicer are feedback to the

equalizer filter B(z) (path 2 in figures 2 and 3). Conversely, when the current sample is outside the square decision region 510 or the LMS error is at or above the threshold, t, then hard decisions are unreliable, the CMA update equation is used, and soft decisions from the received signal input are fed back to the filter B(z). (Applicants' specification, page 14, next to last paragraph)

Although the outermost constellation points are least reliable because they have the most phase error, the CMA algorithm is immune to phase error. Thus, on a sample by sample basis either a linear IIR loop is updated with CMA or a nonlinear DFE loop is updated with DD-LMS. The regressor vector for the feedback filter is thus a hybrid, potentially containing a mixture of soft and hard decisions. For example, the regressor may look like $Y(k)=[y^\wedge(k-1)\ y(k-2)\ y(k-3)\ y^\wedge(k-4)\ y^\wedge(k-5)\ ....\ y(k-N)]T$. The switches 53 and 65 in figures 2 and 3 respectively, are essentially toggled by above decision rules. In addition, the size of the decision box 510, which governs the switch positions, is adaptively selected. (Applicants' specification, page 14, last paragraph)

The specification discloses a decision feedback equalizer switching from using a hard decision sample to using a soft decision sample, and then switching back from using a soft decision sample to using a hard decisions sample again, based on whether the "current sample" meets certain requirements. Figure 6 illustrates the process of operating a decision feedback equalization filter on a "sample by sample" basis.

Initially, the decision box size... [is set].... The flow diagram of figure 6 is entered for each occurrence of the baud clock at step 610, i.e., for every symbol. Then it is determined at step 612 whether or not the current sample falls within the square decision box. If the current sample is not within the square decision box, then CMA is selected for the error function at step 618 and a soft decision is selected as the regressor sample for filtering at step 620. At the same time, a soft decision (or a filtered version) is selected for coefficient adaptation at step 622. CMA equalization using soft decision samples corresponds to the signal acquisition phase of the receiver. The baud counter index, k, is incremented at step 630 and the selection process repeats at step 610. The size (w) of the decision box may be altered at this point. (Applicants' specification, page 15 second paragraph)

If the absolute value of the error is relatively small, i.e., if $|e(k)| < t$, then the decision is said to be reliable. In such case, (i) the DD-LMS error term is selected at step 624, (ii) a hard decision is fed back to the filter B(z) for the filtering operation at step 626, and (iii) a hard decision is used in the parameter adaptation equation at step 628. DD-LMS equalization using hard decision samples corresponds to the tracking phase of the receiver. (Applicants' specification page 16, second whole paragraph.)

On the other hand, if the computed LMS error term is relatively large,(i.e., if $|e(k)| >= t$) at step 616, then the decision is said to be unreliable. In this case, (i) the CMA error term is used 618, (ii) a soft decision is fed back to the filter B(z) for the filtering operation 620, and (iii) a soft decision or a filtered version of the soft decision is used in the parameter adaptation equation 622. The baud counter index, k, is incremented at step 630 and the

selection process repeats at step 610. As before, the size of the decision box may be altered at this point. (Applicants' specification page 16, third whole paragraph.)

Thus, applicant's claim language, directed towards the operation of a decision feedback equalizer using a "first individual signal sample" and a "second individual signal sample" to switch a decision feedback equalizer between first and second modes "on an individual sample by sample basis," is disclosed in the specification.

35 U.S.C. §112

As indicated claims 9, 11-20, and 22-28 are objected to because of various formalities.

In particular, the examiner has indicated that the phrase "update the error terms" in claim 9 lacks antecedent basis. In response, applicants have amended the phrase "update the error terms" in claims 9, 10, 19 and 20 to be "update the filter coefficients" and provided proper antecedent basis for "filter coefficients" in claims 1, 11 and 21.

The examiner has stated that claim 11, line 13 recites "a individual signal samples". Amended claim 11 now recites "a first individual signal sample" and "a second individual signal sample".

The examiner has suggested that in claims 12, 19-20 and 22-28, "an apparatus" should be changed to "a communications receiver". Applicants have made appropriate amendments to claims 12-20 and 22-28.

DUPLICATE CLAIMS

The examiner has noted that claims and 15 and 16 are duplicates of claims 5 and 6, and that

claims 25, 26, 27 are duplicates of claims 32, 33, 34. Applicants have made appropriate

corrections to claims 15, 16 and 25 to avoid duplication of claims.

CITED PRIOR ART PATENT 5,872,815 TO STROLLE ET AL.

Strolle et al. describe a traditional prior art method for operating an adaptive equalization

filter by adjusting the adaptive equalizer coefficients during the signal acquisition period

using the constant modulus algorithm (CMA) technique, which uses soft decision samples.

> In the present application, the FFE 902 and DFE 910 operate as an FIR and IIR pair, as described above, during the signal acquisition period. The coefficients of both the FFE 902 and the DFE 910 are adjusted, simultaneously, using the known CMA technique, until they converge. (Strolle et al., column 13, lines 33-38)

> "In order to simultaneously adapt the coefficients of both the FFE 902 and the DFE 910 during initial signal acquisition, the multiplexer 906 is conditioned to couple the output of the signal combiner 904 to the input terminal of the DFE 910 during the signal acquisition period. Thus, during the signal acquisition period, the FFE 902 and DFE 910 operate as a finite impulse response filter (FIR) and an infinite impulse response (IIR) filter, respectively." (Strolle et al. column 13, lines 17-25)

After the signal acquisition period, Strolle et al. switch to a "normal signal processing"

mode, which uses hard decision samples to adjust the adaptive equalizer coefficients.

> During an initial signal acquisition period, the multiplexer is conditioned to couple the output terminal of the signal combiner to the input terminal of the decision feedback equalizer, and during a normal signal processing period the multiplexer is conditioned to

couple the output terminal of the quantizer to the input terminal of the decision feedback
equalizer. (Strolle et al. column 4, line 65 to column 5, line 4)

The term "period" to describe the signal acquisition phase implies that many (i.e., more

than one) soft decision signal samples are used to adapt the parameters of the decision

feedback equalizer. Thus, after many signal samples are processed in soft decision mode,

Strolle et al. switch over from soft decision samples during the signal acquisition period,

to hard decision samples in the normal signal processing mode.

However, once the switch from soft decision signal samples to hard decision signal

samples is achieved, Strolle et al. DO NOT switch back and forth between hard and soft

decision samples unless the signal has been lost or a new signal is being acquired.

An[other] aspect of digital receiver design concerns the initial acquisition of a digital
signal. This condition occurs whenever power is applied to the receiver, or when a new
signal is tuned, e.g. the user changes the channel. When this condition occurs, the
receiver must adapt to a new digital signal. One adaptation which must be made is the
readjustment of the coefficients in the adaptive equalizer, which is used to compensate
for channel characteristics, to a different channel path. (Strolle et al. column 2, lines 16-
24)

Strolle et al. do not show or suggest operating an equalizer filter in a hybrid fashion, i.e.,

switching back and forth between hard and soft signal samples on "an individual sample by

sample basis". The language of independent claims 1, 11 and 21, as amended, captures this

distinction from Strolle et al.

Specifically, as set forth in amended claims 1 and 21, Strolle et al. do not show or suggest

"switching from said second mode to said first mode responsive to a first
individual signal sample; and

switching back from said first mode to said second mode responsive to a second individual signal sample,

whereby said decision feedback equalizer filter is switched between said first and second modes on an individual sample by sample basis."

Or as set forth in amended claim 11, Strolle et al. do not show or suggest a

"a switch control responsive to a first individual signal sample to operate said first switch from said second mode to said first mode, and responsive to a second individual signal sample to operate said first switch from said first mode to said second mode,

whereby said decision feedback equalizer filter is switched between said first and second modes on an individual sample by sample basis."

CITED PRIOR ART US PATENT 5,363,408 TO PAIK ET AL.

Similarly, Paik et al. recite that "the CMA error is used to train the equalizer (blind equalization), while the DD error is used to complete convergence of the equalizer." See Paik et al. column 8, lines 66-68. The disclosure by Paik et al. does not add to the disclosure of Strolle et al. to render claims 1, 11 and 21, as amended, obvious.

In light of the amendments made herein, applicants request that the examiner withdraw the rejections of claims 1, 11 and 21. Furthermore, dependent claims 2-10, 12-20 and 22-35 are patentable for the same reasons as the independent claims from which depend.

Dependent claims 2-8 and 12-19.

With respect to claim 2, neither Strolle et al. nor Paik et al. nor the combination of them show a method switching between said acquisition and tracking modes "in accordance with the quality of said first and second individual signal samples...." In particular, the cited art does not show a process steps of "measuring the quality level" of first and second individual signal samples, and

"coupling an individual one of said soft decision samples to said decision feedback equalizer filter when said quality of said first individual signal sample is at a first quality level; and

coupling an individual one of said hard decision samples to said decision feedback equalizer filter when said quality of said second individual signal sample is at a second quality level,

wherein said second quality level is greater than said first quality level."

Similarly, with respect to claim 12, neither Strolle et al. nor Paik et al. nor the combination of them show a

"decision feedback equalizer filter mode being operated in said first mode by said switch control when said quality of said first individual signal sample is at a first quality level, said decision feedback equalizer filter mode being operated in said second mode by said switch control when said quality of said second individual signal sample is at a second quality level, wherein said second quality level is greater than said first quality level."

With respect to claims 3-8 and 13-19, neither Strolle et al. nor Paik et al. nor the combination of them show the use of box in the complex plane to determine quality level of the received signal sample.

In particular neither Strolle et al. nor Paik et al. show the use of box "centered about the origin of said complex plane"..."wherein said first individual signal sample is at a first quality level when outside a box of width w, said box of width w being centered about the origin of said complex plane, and said second individual signal sample is at a second quality level when inside said box of width w...." as in claims 3-8 and 13-18. Nor do Strolle et al. or Paik et al. show the use of a reliability area comprising a circle in said complex plane as in claims 5-8 and 15-18.

35 U.S.C. §102(e) and 35 U.S.C. §103 REJECTIONS

Since neither Strolle et al. nor Paik et al. show the subject matter of claims 1-35, as amended, the rejection under 35 U.S.C. §102(e) should be withdrawn. Furthermore, for the above reasons claims 1-35 are not obvious under 35 U.S.C. §103 from Strolle et al. or Paik et al., or their combination.

CONCLUSION

An earnest attempt has been made to present claims patentably distinct from the cited references and to specifically point out how the language of the claims distinguishes those references.

For the foregoing reasons, and in light of the amendments made herein, applicants respectfully request that the examiner withdraw the rejections under 35 USC §112, 35

USC §102(b) and 35 USC §103(a), allow claims 1-35 as amended, and pass the present application to issue.

Respectfully submitted,
by

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